READ: p. 461 -- 463

"A trial as a Hypothesis Test"
"P-Values"
"What to do with an Innocent Defendent"

Ho: p = 0.60 (innocence)   p-value = 0.31
Ha: p > 0.60 (guilt)

Conclusion:
We fail to reject Ho b/c .....

We have ***insufficient evidence*** that the true proportion of ________ is greater than 0.60.

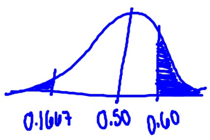
READ p. 483-484
"How to think about P-Values"

Interpreting the P-Value:

There is a P-Value% chance of getting our sample or something more extreme *(use Ha)* if the Ho is true.

$\hat{p} = 0.1667$

$p = 0.50$

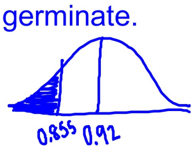


Interpreting P-Values: Ch. 20 CW

1) Ho: p = 0.92   (germination rate)
   Ha: p < 0.92

$\hat{p}$ = 171/200 = 0.855   p-value = 0.0004

There is a 0.04% chance of getting a sample where 85.5% of seed germinate (or less), if it is true that 92% actually do germinate.



Ch. 20 CW
#2) Ho: p = 0.03
    Ha: p ≠ 0.03   (% of twin births)

$\hat{p}$ = 8/469 = 1.706%   p-value = 0.1004

There is a 10.04% chance of getting a sample where 1.7% of births are twins (or something more extreme), if the true % of twin births is really still 3%.

OR There is a 10.04% chance of getting a sample where 1.7% of births are twins (or lower) (or 4.294% or higher are twins) if the true % of twin births is really still 3%.

p. 487 "Significant vs. Important"

p. 491 - 492 "Making Errors"

Ch. 21: Error and Power

Types of Error:

		Truth of the claim: Ho True	Ho False
Reject Ho	DECISION	Type I error α	Power ☺
Fail to Reject Ho		OK	Type II error β

$\alpha = 0.01$
0.001
0.05

EXAMPLE:

		DEFENDANT: Innocent (Ho)	Guilty (Ha)
Jury Decision	Convict (guilty)	Type I error α	Power
	Acquit (not guilty)	OK	Type II error β

Type I Error =

- REJECT Ho WHEN Ho IS TRUE *
- Conclude Ha is true, when Ho is really still true

- P(Type I Error) = ALPHA (α)

Ho: $p = 0.92$
Ha: $p < 0.92$

Saying that the seeds had lost viability when really 92% will germinate.

Type II Error =

- FAILING TO REJECT Ho WHEN Ho IS FALSE *
- Concluding Ho is still true, when really Ha is true.

- P(Type II Error) = BETA (β)

Concluding that 92% of seeds will germinate when really less than 92% will germinate.

Power =

- The probability of REJECTING Ho WHEN Ho is FALSE
- Concluding Ha is true, and being correct!
- GOOD!!

Ho: $p = 0.92$
Ha: $p < 0.92$

- P(Power) = 1 - β
- ***Calculating Power – we won't do it!***
- Power is considered adequate when: IT IS ABOVE 80%

Increasing Power: 2 things we can do to increase power are….

1) Increase n (sample size) *
2) Increase alpha. This gives a larger chance to reject Ho.

$\alpha = 0.05$
p-value: 0.03

Example 1: In Philadelphia it is believed that 12% of motorists run red lights. The city planners decide to put a few traffic cameras that will issue tickets to drivers that run red lights. After 2 months they check out a few corners where cameras had been installed. They found that out of 240 drivers that had the opportunity to run the red light 15 did so and were issued a ticket.

X Does this provide evidence of a decline in the percentage of drivers that run the red light? Use a level of significance of 5%. Assume conditions met already. $\alpha = 0.05$

Ho: $p = 0.12$ Ha: $p < 0.12$

2. What is a Type I error in this context? What is its probability? $\boxed{\alpha = 0.05}$

Concluding the % of red lights run is less than 12% when really the % is still 12%.

3. What is a Type II error in this context?

Concluding the % of red lights run has not gone down, when really it has.

4. Describe what Power means in this context.

The probability of stating that the % of red lights run has gone down, and it has.

5. If they had used a level of significance of 1% what would have happened to the Type I error, the Type II error, and the Power?

orig $\alpha = 0.05$
new $\alpha = 0.01$

power $= 1 - \beta$

Type I – decrease 1
Type II – increase 3
Power – decrease 2

6. How could have they increased the Power without changing the level of significance?

↑ n → ↑ power
↓ Type II
same Type I (α)

1) Ho: p = 0.12
Ha: p < 0.12

$\alpha = 0.05$ p = 0.12
$\hat{p} = 15/240 = 0.0625$

$$Z = -2.741 = \frac{0.0625 - 0.12}{\sqrt{\frac{(0.12)(0.88)}{240}}}$$

P(Z < -2.741) = 0.0031

- We reject Ho b/c p-value of 0.0031 < α = 0.05.
- We have sufficient evidence that the true % of red lights run is less than 12%.

Example 2: p. 502, #26

Ho: visibility of new signs is same
Ha: visibity of new signs is increased/better

a) one tailed (>)
b) Concluding the visibility has increased, when really it's same as old signs.
c) Concluding the signs are not more visible, when really they are.
d) The probability of concluding that the signs are more visible, and they are.

$\alpha = 0.05$
new $\alpha = 0.01$

Type I = decr.
Type II = incr.
Power = decr.
opp.

n=50
new n=20

Type I = same
Type II = incr.
Power = decr.

Example 2: p. 502, #26

(a) one tailed. They are looking for an INCREASE in visibility.
Ho: visibility is the same
Ha: visibility is increased
(b) Saying the signs are more visible, when really they aren't.
(c) Saying the visibility is the same, when really they are more visible.
(d) Probability of concluding that the signs are more visible, and they really are!
(e) original α = 0.05 new α = 0.01
alpha decreases => power decreasing

(f) n decreases => power decreases

Another example: p. 501 #22

Type I
Type II
Power

* The inspectors usually test 100 items. However today they are going to test 200 items. How will this affect the errors and power?

* The inspectors usually use a significance level of 3%. However today they are going to use 6%. How will this affect the errors and power?

Ho: # of defective is same
Ha: # of defective has increased

Type I = Concluding that the # of defective HAS increased, when really it has NOT increased.

Type II = Concluding that the # of defective has NOT increased, when really it HAS increased.

Power = The probability of concluding that the # of defective HAS increased, and it really HAS.

If n increases ... Type I = same Type II = decrease
Power = increase

If alpha increases ... Type I = increase Type II = decrease
Power = increase

VOCAB:

Statistically significant =

- When we reject the Ho (when p-value < alpha)

Example: if $\alpha = 0.05$, which of the following p-values would be significant?

p-val = 0.05

0.00001   0.023   0.034   ~~0.056~~   ~~0.089~~   ~~0.123~~

Example: p. 499, #5

$\alpha = 0.05$ reject ~~Ho: same~~

Ha: better

✓ $\alpha = 0.10$

$\alpha = 0.01$ possibly

Confidence Levels & Significance Levels:

* Confidence levels are 2 sided

* "Match" the Conf. level with the α (significance level) when doing a 2 sided test

* When doing one sided, "match" half the signif. level with the conf level

Ho: $p = 0.50$

Ha: $p \neq 0.50$

$\alpha = 0.10$

Examples:

95% confidence → (0.3, 0.5)

90% confidence → (0.12, 0.31)

Example 4: p. 500, #9. Assume conditions met already.

a) (0.01896, 0.04094) 98% conf.

b) Ho: $p = 0.05$ Reject Ho ...

Ha: $p < 0.05$

c)

$\alpha = 0.01$

9) (a) **Conditions**:

- SRS	- stated random poll
- $n\hat{p}$ & $n\hat{q} \geq 10$	- 39 & 1263 $\geq$ 10
- pop $\geq$ 10n	- there are more than 13,020 working men

conditions met -> Normal Model -> 1 prop Z Interval

$$0.03 \pm 2.326\sqrt{\frac{(0.03)(0.97)}{1302}} = (0.01896, 0.04094)$$

We are 98% confident that the true % of men who said work was a good measure of success was between 1.896% and 4.094%.

(b) Ho: $p = 0.05$ Ha: $p < 0.05$

Since 0.05 is not in the interval, we do not believe that the value of 0.05 is true. The entire interval is below 0.05, so we can conclude that the % has decreased below 5%.

(c) We did a 98% confidence interval, so our level of significance for a one-sided test would be $\alpha = 0.01$.

For a two-sided test it would be $\alpha = 0.02$.

TRADE & GRADE PROBLEM

A report on health care in the US states that 28% of Americans have experienced times when they haven't been able to afford medical care. A news organization randomly sampled 801 Americans and found that 251 of them reported that there had been times in the last year when they had not been able to afford medical care. (assume conditions are met)

a. Does this indicate that this problem is more severe than reported (the % has increased)? Use a 5% level of significance.

b. Are the results statistically significant?

c. Since you rejected the claimed value, use the sample to estimate the true parameter with ***appropriate*** confidence.

d. What is a type I error in context?   (f) Power (in context)

e. What is a type II error in context?   (g) p-value (in context)

TRADE AND GRADE PROBLEM:

(a) $p = 0.28$ $n = 801$ $\hat{p} = 251/801 = 0.3134$

Ho: p = 0.28
Ha: p > 0.28 (2 pts)

Conditions met --> N(0.28,) --> 1 prop Z test (2 pts)

$$Z = \frac{0.3134 - 0.28}{\sqrt{\frac{(0.28)(0.72)}{801}}} = 2.103$$ (3 pts)

P(Z > 2.103) = 0.0177 (3 pts)

We reject Ho b/c p-value of 0.0177 < α = 0.05. We have sufficient evidence that the true % of Americans who had not been able to afford health care in the past is greater than 28%. (4 pts)

(b) YES, the results are significant (we rejected Ho) (1 pt)

(c) Conditions met --> Normal Model --> 1 prop Z interval (2 pts)

$$0.3134 \pm (\quad) \sqrt{\frac{(0.3134)(0.6866)}{801}} = ()$$ (3 pts)

We are 92% confident that the true % of Americans who have not been able to afford health care in the past is btw % and %. (2 pts)

(d) Type I = Saying that there are greater than 28% who can't afford health care, when really it is still 28%. (2 pts)

(e) Type II = Saying there are still 28% who can't afford health care when really is is more than 28%. (2 pts)

(f) Power = The probability of saying there was an increase in the % of Americans without health care, and there was (2 pts)

(g) p-value = There is a 1.77% chance of getting a sample where 31.34% of Americans (or more) don't have health care, assuming that the percent who don't have it is still 28%. (3 pts)